Fifty Caliber Match Ammunition
By
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Introduction

In 1985 a small group of shooters, enthusiastic about sporting uses for the fifty Browning Machine Gun cartridge, formed the Fifty Caliber Shooter's Association (FCSA). Instrumental in the formation of the association was Marty Liggins - at that time a ballistician for Accurate Powder Co. Within a year, Marty had organized the first national shooting competition held in Lodi, WI in which six shooters competed.

In that first match, a 9 5/16" five-shot group at 1000 yards had been fired. This first benchmark gave notice of the long-range potential of the .50 BMG cartridge as fired from a portable, shoulder fired weapon. Within the realm of small-arms, the .50 BMG cartridge possesses the greatest effective range potential. This range potential comes from fifty caliber projectiles possessing a greater transonic range and lower wind deflection than smaller caliber projectiles. These attributes are fundamentally due to the higher ballistic coefficients attainable from .50 caliber projectiles compared with smaller caliber projectiles. The high ballistic coefficient coupled with the variety of projectile types available, gives the .50 caliber its unrivaled long-range capability for a small arm.

An aspect of the FCSA which brought about significant accuracy developments was the quality of people who made up the association. A survey of the membership indicated that 77% of members were educated beyond high school, and 65% were business owners or salaried professionals. Inventive people coupled with the passion that competition brings, has improved the 1000 yard, five-shot group record to 3.2395 inches. Consistent sub-minute-of-angle groups are evident from the six-target aggregate record of 7.4271 inches.

What will be described in the remainder of this paper are the various loading components that make up the precise fifty caliber match round.

Figure 1 - A History of FCSA Records

Single Target / 5-Shots / 1000 yards

1986 - 9.3125" Eric Williams, MO
1991 - 8.75" Bruce Seiler, MD
1991 - 7.1875" Art Guidi, MA
1991 - 6.8125" Dennis Chapman, TX
1991 - 4.25" Skip Talbot, NV
1992 - 4.034" Skip Talbot, NV
1995 - 3.2395" Craig Taylor, WA

Six-Target Average / 1000 yards

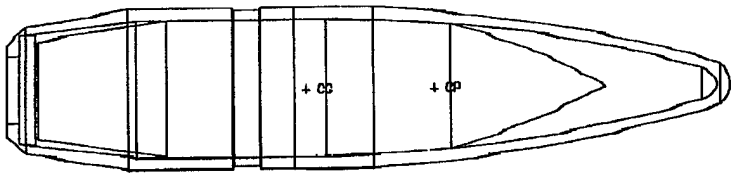
1996 - 8.0417" Buddy Clifton, CA
1997 - 7.4271" Scott Nye, IL

Projectiles

Over the 13 years members of the FCSA have been competing, the most significant advances in technology have come in ammunition. Sorting out the various components in a fifty caliber round, the most effective improvements have come in projectile technology.

As a basis for comparison, Figure 2 shows a drawing of a military API fifty caliber projectile. In order to have a standard model for making fair comparisons, we have analyzed a variety of projectiles using PRODAS - a projectile computer modeling program licensed by Arrow Tech Associates. The calculated properties were derived by first entering the physical dimensions and densities of the bullet components. The bullets were then modeled at a velocity typical as fired from a match rifle. The transonic range represents a maximum effective range. The accuracy potential can be roughly gauged by a combination of the wind deflection numbers (at 1000 yds.) and the dispersion sensitivity. The dispersion sensitivity (lower numbers are better) is dependent on design features of the bullet - most importantly, the placement of the center of gravity. Bullet length is also shown in the tables. This must be considered if the ammunition is to be used in a magazine fed weapon. Only rounds less than ~5.5 inches will feed through magazine fed weapons.

Figure 2 - M-8 API 650 Grain Projectile

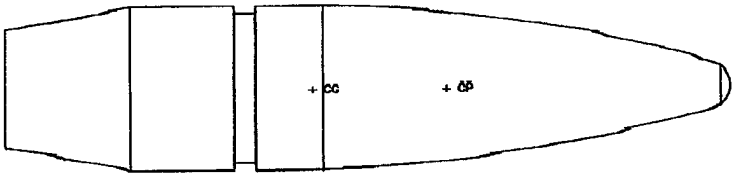


PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.69	**2800**	**1593**	**58.5**	**0.016**	**2.31**

When the association began competition, the only projectile available besides military offerings was the Thunderbird Cartridge Co., Inc. 750 grain solid (Figure 3). This bullet essentially copies the external dimensions of the military API projectile shown above. Being a homogenous brass solid, this bullet is much more consistent than the four-piece military projectile. Due to its greater mass, it has a higher ballistic coefficient than the military projectile giving it better range potential. Although it has a larger dispersion sensitivity than the military projectile, its construction simplicity more than makes up for this deficit. It held all the FCSA records prior to mid-1991, and can easily deliver sub-MOA groups at 1000 yards. A downside to this bullet is its tendency to foul barrels.

Figure 3 - Thunderbird 750 Grain Projectile

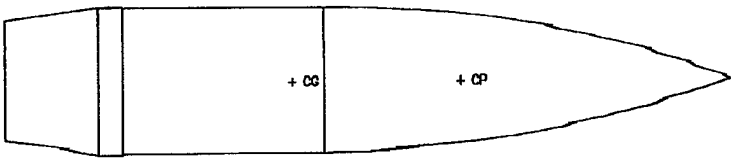


PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.84	2750	1914	47.0	0.020	2.32

In 1991 a small tool company in California (Zero Index) began manufacturing a solid projectile made from a soft steel alloy (Figure 4). The noteworthy attribute of this projectile was its high degree of dimensional precision as a result of being finished by centerless grinding. It also featured a driving band which was added to reduce both fouling and bore wear relative to a fully engraved projectile. This projectile established new records of 4.25 and 4.034 inches in 1991 and 1992 in spite of the fact that its ballistic coefficient was no better than military offerings.

Figure 4 - Zero Index 700 Grain Projectile

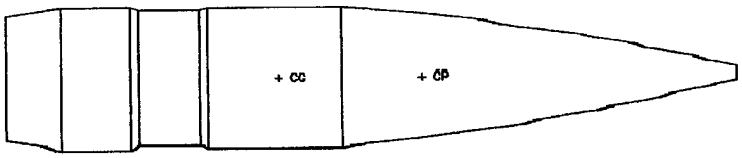


PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.70	2800	1686	57.5	0.015	2.50

The current world record holding projectile is the Barnes 800 grain, bronze solid (Figure 5). This bullet's highly efficient secant ogive coupled with its heavy weight results in a high ballistic coefficient. Even though its heavy weight limits its muzzle velocity, the high ballistic coefficient results in a 29% extension of transonic range over military projectiles. As with the Zero Index bullet, the Barnes offering utilizes a driving band and a bourrelet. This design feature significantly reduces bore wear and fouling. A similar design is also available from Barnes in a 750 grain weight. Both of the Barnes bullets are dimensionally very consistent.

Figure 5 - Barnes 800 Grain Projectile



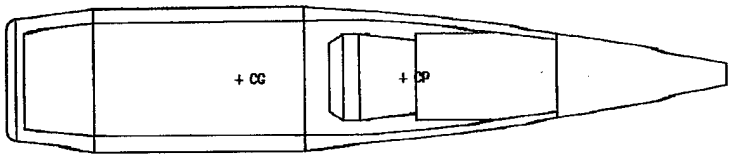
PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.98	2700	2054	40.1	0.018	2.65

A recent and innovative addition to the selection of fifty caliber match projectiles is the Hornady A-Max design. This bullet is partly a traditional lead-cored, copper jacketed bullet. The innovation in this bullet is a sizable aluminum insert placed in the nose. This insert serves two purposes. First, it shifts the bullet's center of gravity rearward resulting in the relatively low dispersion sensitivity; and second, it forms a large part of the efficient ogive. Without the insert, a lead filled design with these dimensions would weigh approximately 900 grains; and could not be fired at desirable velocities.

Although the Hornady bullet has not yet been used in match competition to the degree of the Barnes bullet, it has shown that it is capable of 0.5 MOA groups.

Figure 6 - Hornady A-Max 750 Grain Projectile



PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.96	2750	2073	40.0	0.011	2.56

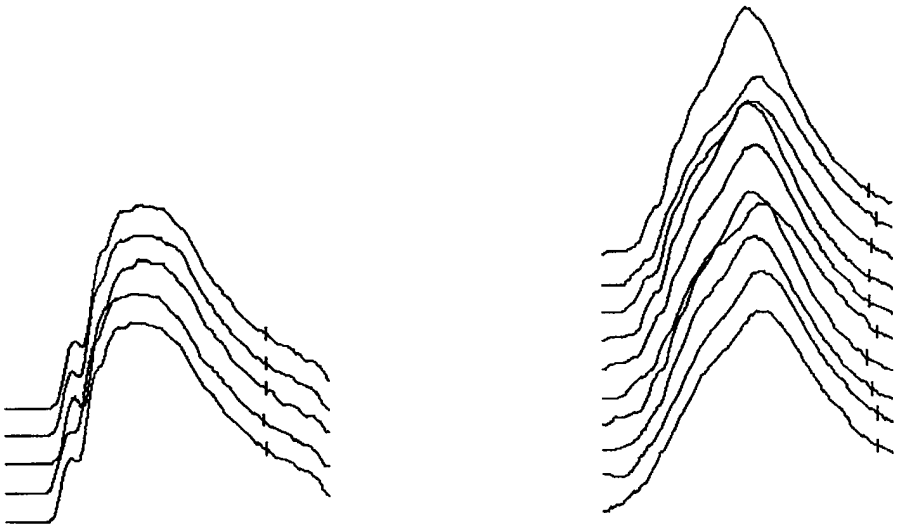
These bullets represent the trendsetters in the sport, but are not the only designs available to shooters. Numerous other small volume producers can be found in the FCSA Suppliers List.

Propellants

Up until the last four years fifty caliber match shooters relied on the supply of surplus military, fifty caliber propellants. These propellants include WC870, WC860, WC872, IMR5010 and T5070 (a renamed spherical propellant of unknown origin). Most of these were quite well matched in burning speed to the fifty caliber case when firing a 650 grain military projectile. However, when used with heavier 750 and 800 grain projectiles these propellants are too fast in burning speed. Because of the poor match between projectile weight and propellant speed, lower than desired loading densities resulted.

Shown below in Figure 7 is a comparison of pressure/time curves between a military load and a load with a poorer loading density. The shot-to-shot consistency can be seen by looking at the overlay of the curves. The military load with the lighter bullet is more consistent than the lower density load.

Figure 7 - P-T Curves of a Military Load and a Low Density Match Load



WC 860 Military
650 gn M33 Ball
55,400 psi (ave.)

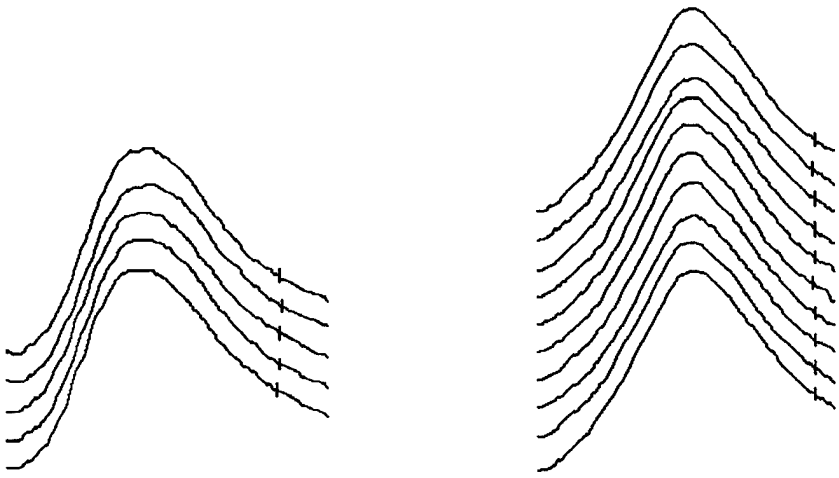
230 gn. T 5070
750 gn TCCI
59,200 psi (ave.)

In 1994 Kaltron-Pettibone began the importation of a 20MM cannon propellant from the Finnish company Vihtavuori Oy. Fifty caliber shooters quickly found that this propellant was well suited to the .50 BMG case when loaded with heavy match bullets. This propellant is the favorite of match shooters, and holds the current world records.

Recently, some samples of Primex's WC886 (a 25MM propellant) were tested in some fifty caliber loads with heavy bullets. This propellant is slower burning, higher in energy and features a more advanced formulation than the older generation fifty caliber Ball® propellants.

Figure 8 shows some pressure/time curves for these two newer propellants. In both cases, the loading density is high and the curves are highly consistent.

Figure 8 - P-T Curves for VV 20N29 and Primex WC886 Propellants With Heavy Match Bullets



250 gn WC 886
750 gn AMAX
55,500 psi (ave.)

250 gn VV 20N29
800 gn solid
56,000 psi (ave.)

Primers

Match reloaders have had, until very recently, only two brands of primers available; namely, the RWS#8212 and the CCI#35. The RWS primer is the 2:1 favorite of match shooters. It is characterized by a soft cup and a lower brisance flame. In contrast, the CCI primer has a hard cup and is higher in brisance.

Very recently, IMI primers have become available. These primers appear to be similar in some characteristics to the CCI primers.

Cartridge Brass

Match ammunition almost exclusively starts with new cartridge brass. For the reloader new brass has been available from Israel Military Industries. This brass, with some preparation steps, is consistent enough to produce good quality match ammunition. The IMI brass was used in all the current FCSA world records.

Another brand, from SNC Industrial Technologies (Quebec), has recently become available to reloaders. In terms of dimensional consistency, this brass is the best available; and will likely become the match shooters' favorite.

US military brass is sometimes used by match shooters. Its major drawback is that it is only available to shooters as machine gun fired. Machine gun fired brass can be highly stretched in the web due to the lack of headspace control in machine guns. Brass which has stretched in the web will not withstand multiple reloads.

Aberdeen Test Center Capabilities Demonstration

In 1997 co-author Buddy Clifton conducted a long-range capability test at Aberdeen Proving Grounds. Buddy fired his light match rifle using his favorite match load at 1200, 1500 and 1900 meters. He also fired a Barrett M82A1 with military Mk211 ammo at the same ranges for comparison. The load Buddy used and the results are shown in the table below.

Projectile - **Barnes 800 gn solid**
Case - **IMI**
Primer - **RWS 8212**
Powder - **258 gn VV20N29**
Velocity - **2690 fps (34" barrel)**

Rifle / Ammo	1200 M ES inches	1500 M ES inches	1900 M ES inches
M82A1 / Mk211	50.9	87.2	151.3
Clifton Match	11.9	31.7	44.9

The data is the average extreme spread for three, three-shot groups. The groups for the match ammunition are one-third to one-quarter the size of the military ammunition demonstrating the superiority of match over mass produced military ammunition.

Summary

Significant advances in fifty caliber ammunition precision have been made by competitive shooters of the Fifty Caliber Shooters' Association over the last 13 years. Commercial bullet makers have made possible the greatest advances in long-range ammunition technology with the manufacture of precision, low drag bullets. These bullets offer a 29% advantage in transonic range when compared to standard military bullets.

Match grade bullets are available as homogeneous solids or as jacketed designs. The solids are more consistent dimensionally, but can be sensitive to varying bore dimensions. The jacketed designs, such as the Hornady, are more tolerant of varying bore dimensions due to their ability to swage or obturate to fit the bore.

The most consistent ammo is produced using slower burning propellants than what is normally used in fifty caliber ammunition. Propellants suitable for 20MM and 25MM cartridges work best in the .50BMG when firing heavy match projectiles.

Currently, the best components available (based on match results and physical measurements) are the Barnes 800 grain solid, Canadian IVI headstamped cartridge brass, RWS primers and Vihtavuori propellant.

Acknowledgments

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We welcome all to visit the Fifty Caliber Shooters' Association's web page at "www.fcsa.org" for more information on the association and the sport.